Functional Status and Self-Rated Health in 2,262 Nonagenarians: The Danish 1905 Cohort Survey

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OBJECTIVES: To describe the functional capacity and self-rated health of a large cohort of nonagenarians.

DESIGN: A cross-sectional survey of all Danes born in 1905 (92–93 years of age), carried out August to October 1998.

SETTING: Participants' homes.

PARTICIPANTS: Two thousand two hundred and sixty-two nonagenarians, corresponding to a participation rate of 63% (of these, 20% participated by proxy).

MEASUREMENTS: Activities of daily living (ADLs) and self-rated health were assessed by interview. Five items from Katz's ADLs (bathing, dressing, transfer, toileting, and eating) were used to construct a three-level five-item ADL scale (not disabled (no disabilities), moderately disabled (1–2 disabilities), severely disabled (3–5 disabilities)). From responses to a more extensive list of questions on ADLs (26 items), we identified scales of strength and agility by means of factor analysis. Furthermore, a 26-item ADL scale was made. Physical performance tests (chair stand, timed walk, lifting a 2.7 kg box, maximum grip-strength, and flexibility tests) were performed among non-proxy responders.

RESULTS: According to the five-item ADL scale, 50% of the men and 41% of the women were categorized as not disabled, while 19% and 22%, respectively, were categorized as severely disabled. The five-item ADL scale correlated highly with the 26-item ADL scale ($r = 0.83$). The ADL scales showed moderate-to-good correlation with each other ($r = 0.74$–0.83), and with the physical performance tests ($r = 0.31$–0.58). Only 3.7% of the women and 6.3% of the men walked (normal pace) with a speed of at least 1 meter per second, which is the minimum walking speed required to cross signaled intersections in Denmark. A total of 56% considered their health to be excellent or good. Of the participants, 74% were always or almost always satisfied with their lives, even though only 45% reported that they "felt well enough to do what they wanted." The analyses showed that no single ADL item seemed to be of particular importance for how the participants rated their health.

CONCLUSION: The Danish 1905 cohort survey is the largest and the only nationwide survey of a whole birth-cohort of nonagenarians. A total of 2,262 fairly nonselected nonagenarians participated. The level of both self-reported disability and functional limitations measured by physical performance tests among nonagenarians was high. Despite their lower mortality, women were more disabled than men and did not perform as well as men in the physical performance tests. Nevertheless, the majority of the participants considered their health to be good and were satisfied with their lives. **J Am Geriatr Soc 49:601–609, 2001.**

Key words: functional status; nonagenarians; oldest-old; ADL; physical performance test

Octogenarians and centenarians are by now relatively well described, but nonagenarians represent an age group whose cognitive and physical features have yet to be investigated systematically.

One of the important questions posed in aging research is whether the additional years in life expectancy, caused by the reduction in mortality among the oldest-old,[1] are characterized by severe disability or by independent, disability-free living. It is well established that the level of institutionalization, disability, and morbidity increases with age. In Denmark, about 10% of the octogenarians[2] and more than 55% of the centenarians[3–5] live in nursing homes, while dependency in ADLs rises from approximately 30% to 70%,[4] and the prevalence of dementia rises from approximately 15%[6,7] to 50%.[5,8] However, we do not know whether dependency increases gradually with advancing age or is compressed in the last years of life among very old people.

There is a gap in our knowledge because only a limited number of surveys that included nonagenarians[9–14] have

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been conducted and sample sizes for this age group have generally been small. We therefore conducted The Danish 1905 Cohort Survey, which was intended to bridge the gap between the surveys of the younger old and the centenarian studies. This survey was a nationwide survey of all Danes born in 1905 and included 2,226 nonagenarians. The overall goal of the survey was to establish a genetic epidemiological database on a large cohort of nonagenarians to elucidate the aging process in the very old, with special focus on physical and cognitive functioning. The large number of participants, of whom approximately 5% are expected to live to be 100 years old, will provide sufficient power to allow detailed future studies of predictive factors for disability, morbidity, and mortality among nonagenarians.

The objective of this paper is to describe the functional capabilities and health of nonagenarians by using three different sets of measurements: self-reported measures of activities of daily living (ADL), objective tests of physical performance, and self-rated health. Furthermore, we compare results on these measures to investigate whether the association between self-perceived and performance-based measures of physical function, which is shown in surveys of younger old people,[15–19] can also be found among the very old. Finally, the association between self-rated health and ADL function is examined.

METHODS

Study Population

The survey has previously been described in detail.[20] In brief, the study includes all Danes born in 1905 and living in Denmark. No exclusion criteria were used. The cohort members were traced through the Danish Civil Registration System, which covers all inhabitants in Denmark through their unique personal identification number. Members of the 1905 cohort received a letter explaining the study and asking permission for an interviewer to come to their residence to conduct a health-related interview and test their mental and physical functioning. They were also asked to give a sample of cells from which deoxyribonucleic acid could be extracted. If the person was unable to participate because of physical or mental impairment, a proxy was encouraged to participate in the interview instead of or with the nonagenarian. Pretesting of the participants was not feasible. The decision of whether to use a proxy was made by the interviewer and the family and caregivers at the initial contact to obtain consent to participate in the interview. The reasons for using a proxy were: dementia (57%), severe sensory deficits (14%), unwillingness to participate personally (14%), and illnesses (14%). Proxies were most frequently children (70%), followed by other relatives (12%), caregivers (9%), spouses (6%), and others (3%). The interviewer contacted the nonagenarians by personal contact or by telephone within 14 days after they received the letter to obtain consent to participate in the survey. The nonagenarians were considered nonparticipants if they did not wish to participate in person or by proxy, or if at least three attempts to contact them, at different times, were unsuccessful. The regional Scientific Ethical Committees of Denmark approved the survey (19980073 PMC).

A total of 3,600 persons born in 1905 (age 92–93 at the time of the survey) were alive at the beginning of the survey and, of these, 2,262 (62.8%) participated, 1,814 (80.2%) in person and 448 (19.8%) by a proxy. We compared participants and nonparticipants by using population-based registry information and found that the participants represented a fairly nonselected group of the 1905 cohort (described in detail in Nybo et al.[20]).

Data Collection and Methods

Following a pilot study comprising 200 persons, 93 interviewers from the Danish National Institute of Social Research carried out the survey during a 3-month period in 1998 (August–October).

The questionnaire included questions on socioeconomic factors, self-rated health, diseases diagnosed by a physician, symptoms of pulmonary and heart diseases, incontinence, pain, fall incidents, fractures, use of medicine, sensory deficits, depression,[21] ADLs, life-style habits, family history, and social life. The questionnaire, with minor changes, has previously been used in The Longitudinal Survey of Aging Danish Twins (LSADT).[21–24]

ADLs were assessed by an expansion of a comprehensive, well-validated Danish ADL-scale (Avlund's PADL),[24,25] covering both basic ADLs and more demanding tasks, (e.g., walking outside for half an hour in bad weather). The scale refers to the ability on the day of the interview. To enhance discrimination between participants, questions about tiredness due to the activities were asked. Furthermore, we added questions on bathing and feeding from Katz's ADL index[26] and questions about functional limitations from the Nagi-scheme[27] (run 100 meters, carry 5 kg, chew hard food, walk 400 meters, and walk up the stairs to the second floor).

Five items covering Katz's ADL index—bathing, dressing, toileting, transfer, and feeding (continence was not included, in accordance with the recommendations in the literature[28])—were used to construct a three-level five-item ADL scale. "Not disabled" was defined as independent in all items, "moderately disabled" as dependent in one or two items, and "severely disabled" as dependent in three or more items. These cutoff scores defined three sizeable groups, which ranged from a group capable of performing the most basic activities independently to a group that was dependent in the majority of the five basic activities.

All ADL items previously used in LSADT were included in the present survey. All items were rated 1 to 4, with the response options being: 1 = cannot do, 2 = can do with aid or major difficulties, 3 = can do with fatigue or minor difficulties, 4 = can do without fatigue. A factor analysis based on LSADT revealed that the 26 ADL items used reflected two subscales. The first factor gave the greatest weight to items related to the ability to walk, go upstairs, and carry weights and was interpreted to reflect a dimension of strength and endurance (strength scale, 11 items). The second factor gave the greatest weight to items focused on ability to dress and wash oneself and get in and out of bed and was interpreted to reflect a dimension of agility (agility scale, 11 items). Finally a 26-item ADL scale comprising all items was constructed. (For further details see Christensen et al. 2000.[24]) These three scales, which we named "functional ability scales" are used in the present

paper because almost identical factor loadings were found when applying these scales to the data from the 1905 cohort, suggesting that the dimensions are also very reliable in a large sample of very old persons.

Taking into account the age and expected functional capacity of the study population, we composed tests of physical performance. The intention was to cover performance domains important to physical functional independence (e.g., flexibility and strength in upper and lower body). Included were: ability to bring hands to neck, loin, and toes of the opposite foot (flexibility tests); single chair stand with or without the use of arms and ability to lift a box weighing 2.7 kg above the head (strength tests) (for scoring see Table 1); and timed walk over a distance of 3 meters (normal pace). Two trials were completed and the fastest one was used for the analyses. The subject was allowed to use a walking aid, if necessary. These tests were, with minor changes, performed according to the protocol from the Women's Health and Aging Study.[29] Handgrip was tested using a handheld dynamometer (SMEDLEY'S dynamometer TTM), for three performances with the strongest hand.

RESULTS

The basic characteristics of the cohort are shown in Table 2.

For all ADL items, the frequencies of persons who "can do without fatigue," "can do with fatigue or minor difficulties," "can do with aid or major difficulties," or "cannot do," respectively, are shown in Table 3. Furthermore, mean scores for the items and for the three functional ability scales (strength, agility, and 26-item ADL scale) are shown. Men from the 1905 cohort managed, on average, all ADL activities better than women and scored higher than women on the functional ability scales (analysis of variance (ANOVA) $P < .001$). Activities on the strength scale represented the most difficult tasks. On this scale, the participants were, on average, categorized as "can do with aids or major difficulties" (mean score men = 2.08, women = 1.73) and on the agility scale, on average, as "can perform the activity with fatigue or minor difficulties" (mean score men = 2.99, women = 2.63).

According to the five-item ADL scale, 50.1% of the men and 40.7% of the women were classified as not disabled (Table 4). Proportionately fewer men were dependent in each ADL item. In all items except feeding and going to the toilet the difference was highly significant (chi-square test, $P < .001$). Among proxies, there were no sex differences in the ADL pattern. The task in which most of the respondents were dependent was bathing (women = 52%, men = 46%), followed by dressing, toileting, transfer, and feeding.

In Table 5, the physical performance test results are shown along with the five-item ADL scale. There is a substantial decline in mean test performance with increasing level of disability, along with an increasing proportion of persons who were unable to complete the tests. We used a one-way ANOVA to test whether there was a significant difference between means (e.g., between the not disabled and severely disabled) for the four tests of physical performance. Because the one-way ANOVA tests were highly significant ($P < .001$) "multiple comparisons" were performed to test whether there were also significant differences between all three disability levels in the five-item scale and the tests. We found that there were significant differences in means along all three disability levels for handgrip measurements, flexibility tests, and strength tests. For walking speed we found no significant difference between the severely disabled and the two other groups (Dunnet C-test, $P > .05$). The trend was linear for handgrip and walking speed, while there was a nonlinear relationship for the flexibility and strength tests (Table 5). Men performed better than women in all tests (chi-square test, $P < .001$) except in the flexibility tests (chi-square test, $P = .15$).

The walking speed ranged from 0.06 meters per second to 1.5 meters per second, and for both sexes the severely disabled walked approximately half as fast as the not disabled. A total of 3.7% of the women and 6.3% of the men had a normal walking speed of at least 1 meter per second, which is the minimum walking speed required for crossing signaled intersections in Denmark. A walking aid was used by 45% of the participants who completed the test. Walking was the most demanding test, with 406 (22.5%) of the nonagenarians unable to complete the test, either because they could not walk at all (n = 199), or for other reasons (illness, sensory deficits, the participant or the interviewer felt it was not secure). Fewer than 7% of the subjects were unable to attempt/complete the remaining tests.

Table 1. Scoring of the Physical Performance Tests

Physical Performance Tests	Score
Strength tests composed of the sum of the following two tests*	
Upper extremity strength—lift 2.7 kg box over the head	
Able to lift over head	3
Able to lift to eye level	2
Able to lift a few centimeters	1
Unable	0
Lower extremity strength—chair stand	
Able to stand without use of arms	2
Able to stand with use of arms	1
Unable to stand	0
Flexibility tests composed of the sum of the following three tests†	
External shoulder rotation—arms to neck	
Able to complete fully	2
Able to complete partially	1
Unable to complete	0
Internal shoulder rotation—arms to loin	
Able to complete fully	2
Able to complete partially	1
Unable to complete	0
Hip flexion—hands to opposite big toe or ankle or knee	
Able to reach opposite big toe	2
Able to reach opposite ankle	1
Able to reach opposite knee	0

Note: Right and left arms scored separately.
*Minimum score = 0, maximum score = 5.
†Minimum score = 0, maximum score = 12.

Table 2. Type of Interview and Demographic Characteristics of Subjects in the Danish 1905 Cohort Survey Conducted in 1998

	Men n = 584	Women n = 1,678	Total n = 2,262
Interview type			
In person	494 (84.6%)	1,320 (78.7%)	1,814 (80.2%)
By proxy	90 (15.4%)	358 (21.3%)	448 (19.8%)
Type of residency			
House/apartment	339 (58.0%)	846 (50.4%)	1,185 (52.4%)
Sheltered housing/nursing home	245 (42.0%)	832 (49.6%)	1,077 (47.6%)
Marital status			
Married	171 (29.3%)	56 (3.3%)	227 (10.0%)
Widow/widower	372 (63.7%)	1,365 (81.3%)	1,737 (76.8%)
Divorced	12 (2.1%)	67 (4.0%)	79 (3.5%)
Single	29 (5.0%)	190 (11.3%)	219 (9.7%)
Education			
<7 years	136 (23.3%)	373 (22.2%)	509 (22.5%)
7–8 years	330 (56.5%)	999 (59.5%)	1,329 (58.8%)
9–10 years	67 (11.5%)	214 (12.8%)	281 (12.4%)
11+ years	39 (6.7%)	45 (2.7%)	84 (3.7%)
Unknown	12 (2.1%)	47 (2.8%)	59 (2.6%)

Correlation analyses of the relation between the five-item ADL scale and the physical performance tests showed that the correlation between the five-item ADL scale and the objective measures of physical function ranged between 0.31 and 0.58 (handgrip $r = 0.31$, walking speed $r = 0.39$, flexibility tests $r = 0.47$, and strength tests $r = 0.58$). By using the 26-item ADL scale instead of the five-item ADL scale, the correlations increased to a range of 0.46 to 0.68 (handgrip $r = 0.46$, walking speed $r = 0.63$, flexibility tests $r = 0.57$, and strength tests $r = 0.68$).

There is a significant difference (chi-square test, $P < .001$) between the disability group's rating of health, life satisfaction, and ability to do what they want (Table 6), but even among the severely disabled, a large proportion of the respondents stated that their health was "excellent or good" (men = 39.0%, women = 36.0%), and in this group 52.5% of the men and 55.0% of the women were "always or mostly" satisfied with their lives, even though only 20.3% and 14.0%, respectively, reported that they "felt well enough to do what they wanted." Men who reported their health as poor/very poor were almost equally distributed in the three disability groups (not disabled 30%, moderately disabled 36%, and severely disabled 34%), while, among women, the largest proportion could be categorized as "moderately disabled" (not disabled 21%, moderately disabled 54%, and severely disabled 25%).

To determine whether any specific ADL items were important for how the participants rated their health, we calculated mean scores for the ADL items, dividing participants into three groups according to their self-rated health (excellent/good, acceptable, and poor/very poor). The analyses showed that no single ADL item seemed to be of particular importance for how the participants rated their health. For the majority of items, there was a decline in mean score of approximately 0.8 to 1 between persons who rated their health as excellent/good and persons who rated their health as poor/very poor. However, the difference in mean score was very small (0.12 to 0.25), both for the items that were the most difficult to perform (perform hard exercise, walk outside in good or bad weather for half an hour, and run 100 meters) and for items that were very easy to perform (eat and comb one's hair). The highest differences in mean score were found for the ability to walk 400 meters (1.38) and the ability to climb the stairs to the second floor (1.22).

DISCUSSION

The level of disability and functional limitations were high among the nonagenarians. More than half (49.9% of the men and 60.3% of the women) were disabled in at least one of the most basic activities covering Katz's ADLs. Considering the higher mortality rates for male nonagenarians, it is striking that men on average manage the ADL items and the tasks in the physical performance test battery much better than women do. Only 3.7% of the women and 6.3% of the men walked (normal pace) with a speed of at least 1 meter per second. Despite this, most of the participants in general considered their health to be good and were satisfied with their lives. No single ADL item seemed to be of particular importance for the rating of health.

In the present survey, disability was among others measured with a modified Katz's ADL scale. In general, we found the proportion of not disabled subjects to be lower (50.1% of the men and 40.7% of the women were not disabled) than have other surveys including nonagenarians that used Katz's ADL scale. This may be due in part to the small sample sizes and exclusion of, for example, demented persons and persons living in nursing homes in the comparable surveys. In the established populations for epidemiologic studies of the elderly (EPESE) surveys, where only noninstitutionalized persons were included,[30] the percentage of not disabled persons varied between the study centers from 46% to 63% for men and from 43% to 63% for women. In the Leiden survey, with 105 participants age 85 and older (mean age 89),[31] 60% were found not disabled. In this sample, only 5% lived in nursing homes,

Table 3. Functional Abilities in the Danish 1905 Cohort Survey

	Men					Women				
	Can Do Without Fatigue %	Can Do with Minor Difficulty or Fatigue %	Can Do with Aid* or Major Difficulty %	Cannot Do %	Mean Score	Can Do Without Fatigue %	Can Do with Minor Difficulty or Fatigue %	Can Do with Aid* or Major Difficulty %	Cannot Do %	Mean Score
Strength scale										
1. Walk around in the house†	50.6	7.9	29.8 (1.7)	11.7	2.97	36.3	8.7	40.9 (2.3)	14.1	2.77
2. Walk up and down stairs one floor‡	35.5	23.2	8.7	32.6	2.62	24.6	20.2	10.3	44.9	2.25
3. Walk up the stairs to the 2nd floor†	25.0	15.8	20.7 (5.8)	38.5	2.27	16.7	11.3	20.0	52.0	1.93
4. Able to get outdoors†	33.8	7.4	38.6 (5.7)	20.2	2.55	20.7	5.8	41.8 (11.4)	31.7	2.15
5. Able to walk 400 meters without resting‡	38.7	14.7	4.7	42.0	2.50	23.8	14.9	5.0	56.4	2.06
6. Do light exercise§	31.8	11.1	1.4	55.7	2.19	18.3	9.6	1.3	70.8	1.75
7. Do hard exercise§	6.1	6.4	1.2	86.3	1.32	2.4	2.8	0.4	94.3	1.13
8. Walk in nice weather for 1/2–1 hour†	9.3	1.4	2.9 (0.9)	86.4	1.33	3.2	0.9	1.4 (1.0)	94.5	1.13
9. Walk in bad weather for 1/2–1 hour†	8.1	1.6	2.9 (0.9)	87.4	1.30	2.7	0.8	1.1	95.3	1.11
10. Run 100 meters‡	1.9	1.7	0.7	95.7	1.10	0.8	0.7	0.1	98.4	10.4
11. Carry 5 kilos‡	45.4	13.0	6.6	35.3	2.68	13.8	14.4	6.0	65.7	1.76
Strength scale score					2.08					1.73
Agility scale										
12. Get up from chair†	60.0	7.4	26.8 (5.0)	5.8	3.12	49.3	9.3	33.0 (5.9)	8.4	2.99
Get up from bed†	62.5	5.2	26.1 (8.6)	6.2	3.24	50.5	8.6	31.7 (9.4)	9.2	3.00
13. Able to go to the toilet†	59.1	7.2	26.4 (10.8)	7.4	3.12	48.9	8.0	34.0 (11.5)	9.0	2.91
14. Wash upper part of body†	55.7	8.4	23.1 (14.7)	12.8	3.07	47.5	13.7	23.8 (13.1)	14.9	2.94
15. Wash lower part of body†	48.4	7.2	24.1 (17.1)	20.2	2.84	43.2	11.1	23.3 (16.5)	22.5	2.75
16. Wash hair‖	52.9	6.9	—	40.1	2.73	23.7	6.9	—	69.4	1.85
17. Dress upper part of body¶	65.1	9.0	15.1 (15.1)	10.8	2.28	54.9	15.9	14.4	14.9	3.19
18. Dress lower part of body¶	61.3	8.8	16.5 (16.5)	13.4	3.16	50.5	14.1	16.7	18.7	2.96
19. Take socks and shoes on and off#	55.3	11.7	8.1	24.9	2.97	45.9	13.4	8.6	32.1	2.73
20. Comb hair‖	83.4	5.5	—	11.1	3.61	69.0	11.1	—	20.0	3.29
21. Cut toenails‖	19.1	6.3	—	74.7	1.70	13.7	4.7	—	81.5	1.15
22. Cut fingernails‖	57.8	1.7	—	40.5	2.77	48.4	4.9	—	46.8	2.55
Agility scale score					2.99					2.73
26-item scale (remaining items)										
23. Chew hard food‡	40.8	29.9	13.1	16.2	2.95	35.3	30.4	13.1	21.2	2.80
24. Eat without help**	83.7	12.5	—	3.8	3.76	80.5	14.5	—	5.0	3.71
25. Can read ordinary newspaper text‡	55.3	13.3	10.2	21.3	3.03	48.9	15.2	8.4	27.6	2.85
26. Hear conversation between 3 or more persons‡	22.2	29.7	18.6	29.5	2.45	23.6	27.7	17.3	31.4	2.43
26-item-scale score					2.61					2.34
Additional item										
27. Take a bath††	45.2	—	8.8	46.0	2.44	32.5	—	15.5	52.0	2.13

Note: Because response options were not the same for all activity of daily living items we recoded all items into 4 categories (original categories below) and rated them 1 to 4 with the response options being: 1 = cannot do, 2 = can do with aid or major difficulties, 3 = can do with fatigue or minor difficulties, 4 = can do without fatigue. The table indicates to which of the 3 functional ability scales the items belonged. We furthermore calculated mean scores for the individual items and for the 3 functional ability scales by taking the average response of the items.

Response categories:

*Aid is defined as helping equipments or help from a person. Figures in the parentheses state percentage of persons who need help from another person.

†1: yes, 2: yes, with fatigue, 3: yes, with aid or with help from a person, 4: no.

‡1: yes, 2: yes, with minor difficulty, 3: yes, with major difficulty, 4: no.

§1: yes, 2: yes, daily or more times a week, 3: one time a week or 2–3 times a month or one time a month, 4: no.

‖1: yes, 2: yes, with fatigue, 4: no.

¶1: yes, 2: yes, with fatigue, 3: yes, help from a person, 4: no.

#1: yes, 2: yes, with fatigue, 3: yes, with aid, 4: no.

**1: yes, without help, 2: help to cut bread, 4: no.

††1: yes, without help, 2: yes, with help to one part of the body, 3: yes, with help to more than one part of the body, 4: no.

Table 4. Percentage of Dependent Nonagenarians and Distribution on the Five-Item ADL Scale in the Danish 1905 Cohort Survey*

	Men	Women	Total
Bathing (n = 2,242)			
All	46.0	52.0	50.4
Nonproxy/proxy	38.5/87.6	42.8/85.9	41.6/86.2
Dressing (n = 2,247)			
All	32.2	41.2	39.2
Nonproxy/proxy	24.2/83.1	31.3/78.8	29.3/79.1
Going to the toilet (n = 2,262)			
All	18.2	20.5	19.9
Nonproxy/proxy	11.5/54.4	10.8/56.4	11.0/56.0
Transfer (n = 2,250)			
All	15.5	19.2	18.3
Nonproxy/proxy	10.3/43.8	10.5/51.5	10.5/50.0
Feeding (n = 2,247)			
All	3.8	5.0	4.7
Nonproxy/proxy	1.0/18.9	1.0/19.9	1.0/19.6
Five-item ADL scale (n = 2,244)			
All			
Not disabled	50.1	40.7	43.1
Moderately disabled	31.3	37.8	36.1
Severely disabled	18.6	21.5	20.8
Five-item ADL scale (n = 1,792/446)			
Nonproxy/proxy			
Not disabled	57.8/7.8	49.0/10.1	51.4/9.6
Moderately disabled	30.1/37.8	39.5/31.5	36.9/32.7
Severely disabled	12.0/54.4	11.5/58.4	11.6/57.6

*The five-item activities of daily living (ADL) scale is formed from the following items in Table 3: item 12 (transfer- independent: no help/uses aids, dependent: needs help from a person/cannot perform the task), 13 (toileting- independent: no help/uses aids, dependent: needs help from a person/cannot perform the task), 17–19 (dressing- independent: no help in all 3 items, dependent: needs help from a person/cannot perform the task), 24 (feeding- independent: no help/help to cut the food or butter a slice of bread, dependent: needs help from a person) and item 28 (bathing-independent: no help/help to one part of the body, dependent: needs help from a person or does not take a bath). Definitions of disability level: Not disabled = independent in all items, Moderately disabled = dependent in 1 or 2 items, Severely disabled = dependent in 3, 4, or 5 items. Number of persons differs due to missing values.

while the corresponding figure in our survey was 31%. Among 183 people age 90 and older in the Kungsholmen project,[32] 40% were categorized as not disabled. An Italian survey[9] of centenarians and nonagenarians free of major diseases found that 35% (n = 13) of the men and 6% (n = 3) of the women could be categorized as not disabled. Nevertheless, the functional ability scores in the present survey were highly comparable with the scores obtained from the nonagenarians in LSADT (n = 144),[24] a Danish study using virtually the same instrument as this study.

The substantial difference in ADL performance between the sexes is well known from the literature. Studies have shown that sex differences become progressively larger with age, which is in sharp contrast to the higher survival rate of women.[4,24,30,33–35] This remains to be explained. It could be due to the physiological and psychological differences in functional capacity (e.g., body composition and exercise tolerance[36]) between the sexes, or to the fact that men represent a more selected group, considering their higher mortality rate. It is also likely that the underlying causes of disability and the relationship between disease severity and disability severity may be different in men and women.[37] Finally, nonagenarian men tend still to be living in the social context that characterized most of their adult lives because a larger proportion of the men lived independently and were still married and thus had the responsibility for doing some of the more demanding tasks in the household (e.g., cutting the grass and trimming the hedges). Even if these tasks are fairly easy in absolute terms they may have a training effect, thus maintaining strength at a higher level because older people may need to use almost their maximal strength to perform such tasks.[38]

Physical performance measures were included in the present study to provide objective and detailed information about functional capacity, but the presumed high prevalence of disabilities and sensory deficits prevented many of the instrument batteries developed for studies of younger old people from being suitable for use in a cohort of very old people.[3,9] We therefore selected the physical performance tests carefully in consideration of the age and expected functional capacity of the study population. We believe that the tests were well chosen because the majority of the participants were able to complete the tests. Furthermore, identifying inability to perform a test also provides meaningful information on individual functioning.[29] The test in which most subjects could not participate was, not surprisingly, the walking test. Walking requires the coordinated function of a number of subsystems, including muscular strength, joint mobility, coordination, proprioception, reflex control, and balance;[29] many different kinds of pathology such as stroke, fractures, arthritis, and Parkinson's disease contribute to walking impairment.

The walking speed (normal pace) in the 1905 cohort survey was, on average, 0.64 meters per second among men and 0.52 meters per second among women. Figures for people age 85 and older in the Cardiovascular Health Study[39] were 0.75 meters per second and 0.6 meters per second, respectively, but in that survey only community-dwelling persons were included. In the Women's Health and Aging Study (WHAS),[29] women age 85 and older (n = 303) were on average able to walk 0.4 meters per second. Only a very small minority of the participants in the present survey walked with a velocity that would allow them to cross the street while the green light was on. This, as well as sensory deficits, makes it very difficult for these very old people to manage in traffic because they would have to increase their normal walking pace substantially.

Handgrip performance among the nonagenarians (mean values: men 22.8 kg, women 13.4 kg) was, as expected, lower compared with the performance in surveys of younger persons. In a survey of 4,223 Danish middle-aged twins (born in 1931–1952) that used the same instruments and logistics as the present survey, the mean handgrip among men was 48 kg and among women 28 kg.[40] Among those age 85 and older in the Cardiovascular Health Study,[39] the men (n = 102) had a maximum handgrip of approximately 29 kg and the women (n = 91) of 18 kg.

Table 5. Physical Performance Tests According to Status on the Five-Item Activities of Daily Living Scale in the Danish 1905 Cohort Survey*

	Men				Women			
	Not Disabled (n = 284)	Moderately Disabled (n = 148)	Severely Disabled (n = 59)	All (n = 491)	Not Disabled (n = 641)	Moderately Disabled (n = 516)	Severely Disabled (n =150)	All (n = 1,307)
Max. handgrip (kg) —mean (SD)	24.6 (6.1)	21.3 (6.0)	16.1 (5.1)	22.8 (6.5)	14.8 (4.2)	12.3 (4.4)	10.0 (4.1)	13.4 (4.5)
Unable to complete test	1.8%	8.1%	16.9%	5.5%	3.6%	10.5%	30.7%	9.4%
Walking speed (m/sec) —mean (SD)	0.71 (0.27)	0.50 (0.21)	0.40 (0.28)	0.64 (0.28)	0.60 (0.25)	0.42 (0.20)	0.29 (0.14)	0.52 (0.25)
Unable to complete test	6.3%	23.0%	88.1%	21.2%	9.4%	22.3%	82.7%	22.9%
Flexibility-tests (score)† —mean (SD)	11.0 (1.9)	9.4 (2.8)	6.5 (3.7)	10.1 (2.7)	10.9 (1.9)	8.9 (3.2)	5.8 (3.8)	9.7 (3.1)
Unable to complete tests	1.1%	6.7%	30.5%	6.3%	2.8%	7.1%	29.3%	7.5%
Strength-tests (score)‡ —mean (SD)	4.7 (0.5)	4.1 (0.9)	2.6 (1.3)	4.3 (1.0)	4.4 (0.9)	3.5 (1.2)	1.8 (1.4)	3.7 (1.3)
Unable to complete tests	1.1%	4.7%	8.4%	3.1%	1.2%	3.2%	8.6%	2.9%

*Missing data on 18 persons.
†0 = No points in any item, 12 = maximal points in all items; see Table 1.
‡0 = No points in any item, 5 = maximal points in all items; see Table 1.
SD = standard deviation.

The correlation analyses showed a poor correlation between handgrip, walking time, and the five-item ADL scale ($r = 0.31$ and $r = 0.39$). Using the 26-item ADL scale, the correlation was moderate ($r = 0.46$ and $r = 0.63$). This indicates that handgrip and walking speed measure a dimension of functional ability among the very old that is not represented to any major extent in the five-item ADL scale. This also indicates, as expected, that no single measure fully characterizes the functional ability of the 1905 cohort; the self-reported and performance-based measures are to some extent complementary.

Table 6. Subjective Health Variables According to Status on the Five-Item Activities of Daily Living Scale in the Danish 1905 Cohort Survey*

	Men				Women			
	Not Disabled (n = 284) %	Moderately Disabled (n = 148) %	Severely Disabled (n = 59) %	All (n = 491) %	Not Disabled (n = 641) %	Moderately Disabled (n = 516) %	Severely Disabled (n = 150) %	All (n = 1,307) %
How do you consider your health in general?†								
Excellent/good	64.4	48.6	39.0	56.6	67.2	46.5	36.0	55.4
Acceptable	30.3	39.2	32.2	33.2	27.9	37.8	39.3	33.1
Poor/very poor	5.3	12.2	28.8	10.2	4.9	15.7	24.7	11.4
Are you satisfied with life at present?††								
Always/mostly	78.9	67.3	52.5	72.2	82.8	70.2	55.0	74.6
Now and then	13.7	21.8	23.7	17.3	10.8	19.5	24.8	15.8
No	7.4	10.9	23.7	10.4	6.4	10.3	20.1	9.5
Do you feel well enough to do what you want?§								
Always/mostly	66.5	35.8	20.3	51.7	58.7	32.0	14.0	43.0
Now and then	17.3	25.0	13.6	19.1	24.0	25.4	19.3	24.0
No	16.2	39.2	66.1	29.1	17.3	42.6	66.7	33.0

*Only nonproxy data included.
†Missing data on 12 persons.
‡Missing data on 16 persons.
§Missing data on 13 persons.

It is noticeable how positively the nonagenarians rate their health, but this has also been found in other surveys of the oldest old. In the Canadian Health and Aging Study,[41,42] approximately 21% of those 90 to 95 years old rated their health as very good and 55% as pretty good, with a significant increase in positive rating with increasing age. The latter is also found in the Cambridge Project for Later Life.[43] In this survey, 39% of those age 90 and older (n = 76) rated their health as very good compared with other persons of the same age. In The Kungsholmen Longitudinal Survey,[32] 66% of those age 90 and older (n = 196) regarded themselves as healthy and 20% as not healthy. The figures for the 1905 cohort are 16% (very good) and 39% (good).

Even the severely disabled rate their health very positively. This lack of relationship between self-assessed health, life satisfaction, and functional status is striking. These findings parallel those described by Covinsky et al.[44] in a study of patients age 80 and older. The authors found that disagreement between the patients' reported health status and their perception of global quality of life was common. There may be several explanations for this discrepancy; the meaning of the above questions differs for very old people compared with younger old people. Also, very old people who expect some degree of disability may rate their health and life satisfaction by comparing their health status with what they expect, rather than with "perfect health." Furthermore, the capacity to adapt to declines in health status may vary, depending on personal traits, psychological status, social support, and characteristics of the external environment.[44] Also, there may be differences in comorbidity at the same disability level that are associated with self-rated health. Finally, only 5% (2.3% of the men and 7.3% of the women) of the original 1905 cohort were alive at the beginning of the survey; the fact that so few of the cohort are still alive may introduce a positive view on health even if the person is disabled.

What is also remarkable is that the differences between the sexes regarding level of disability and physical performance did not seem to be reflected in their self-rated health (i.e., men were not more positive about their health than women). This suggests that, in measuring the well-being of very old people, it is important not only to measure functional ability but also to take into account participant's perceptions of health and life satisfaction. It also has implications for how we take care of older people because life satisfaction does not depend only on health or functional status.

A number of methodological issues in the 1905 cohort survey need to be addressed. The nonparticipation rate was relatively high and could be related to functional status. It has been suggested that nonresponse is correlated with severity of disability.[45,46] However, we believe that the use of proxies in the survey ensured that even the most impaired individuals were able to participate, and the analysis shows, as expected, that participants interviewed by proxy were much more disabled than nonproxy participants. A register-based analysis of the relationship between participants and nonparticipants (for details see Nybo et al.[20]) showed no differences between the two groups with regard to residence type, marital status, or hospitalization patterns in 1998, when the survey was conducted, or in the previous 26 years. Men and residents of rural areas were more likely to participate, which is often seen in surveys among older people.[22,46,47] Nevertheless, the mortality rate 6 months after the start of the survey was significantly higher among nonparticipants than among participants, indicating that terminal illness was one reason for nonparticipation.

In conclusion, the level of both self-reported disability and functional limitations measured by physical performance tests among nonagenarians was high. Despite their lower mortality, women were more disabled than men and did not perform as well as men on the physical performance tests. Nevertheless, most of the participants considered their health to be good and were satisfied with their lives.

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